ACTIVE EARLY

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"Perfection of means and confusion of goals seems to characterize our age"
- Albert Einstein

ACTIVE EARLY PRINCIPLES*

Introduction: I have been extremely fortunate to have travelled broadly in teaching orthodontics throughout my career. One of the aspects that seems to create a great deal of confusion among orthodontists around the world is the relationship between the means of using a "straight wire" appliance to align teeth and the contemporary clinical goals of excellence in both esthetics and occlusion.

Every orthodontist is familiar with the brilliant article by Andrews[1], which introduced the basis of "straight wire" theory, which has dominated our profession for the last 40 years. Building tip, torque, and in/out into the bracket as a means of avoiding adverse "wagon wheel" effects of wire bending is the premise of every modern orthodontic appliance, and to this day, I use pre-adjusted appliances for this reason.

As with all great ideas, "Straight Wire" theory has some recognized limitations. Thomas Creekmore and Randy Kunik provided a good summary of these: inaccurate bracket placement, variation in tooth structure and tooth facial morphology, variations in the maxilla/mandible skeletal relationships, tissue rebound, mechanically deficiencies in the appliances[2], and variable threshold of biological activation, to name a few. The combination of all these factors reduces the ability of the clinician to rely strictly on the appliance to guarantee an excellent occlusal result, with an even less likelihood of reaching superior esthetic goals.

For me, there are three significant considerations of straight wire theory as it applies to using a contemporary PSL appliances in esthetics based treatment:

- The first of these is revolves around the core straight wire principle that the wire plane parallel to the occlusal plane is a requisite for excellent occlusions. It is not, and failure to adjust bracket position to meet esthetic need can result in esthetic decline[3] in many patients. The contemporary Orthodontist needs expand his/her diagnostic and mechanical understandings beyond reliance on improved "straight wire" appliances to attain superior esthetic results. David Sarver has led the charge on the impact on esthetics of orthodontic treatment mechanics[4] where the vertical position of the upper incisor is the prime diagnostic criteria in developing superior esthetics in orthodontics, and I agree with this concept.

- The second involves the misconception that incremental increases in arch wires size is an effective means of controlling axial inclination. It is not, and failure to appreciate how to control axial inclination results in frustration in many orthodontists when reliance on "the treatment built into the appliance" fails to deliver.

- The third limitation involves the lack of appreciation of the pivotal role of case management in attaining superior aesthetic and occlusal results. The best orthodontic results are attained by the best case managers, regardless of the appliances they use.

Today I would like to explore briefly the elements that are within the control of the Orthodontist; bracket position, appropriate use of pre-adjusted appliances, and arch form as they relate to esthetic outcomes.

Figure 1: Beautiful Smile Arc - The vertical position of the upper anterior teeth relative to the upper posterior teeth determines the Smile Arc. Importantly the Smile Arc extends from first molar to first molar.

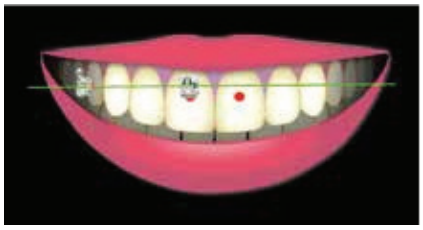

Figure 2: SAP bracket placement - to protect the Smile Arc, and improve enamel display, brackets may be positioned in a more more gingival position on the upper anteriors than the upper posteriors. This approach may require a wire plane that is gingival to FA, and not parallel to the upper occlusal plane.

Figure 3: SAP versus Traditional bracket placement: in situations with flat upper occlusal planes, or where more enamel display is required placing brackets with the wire plane parallel to the occlusal planes adversely impacts esthetics.

Bracket Position as it effects Contemporary Esthetic Goals:

For many years, I have been teaching the ***"Top 10 Esthetic Factors"*** that can be impacted by orthodontic mechanics. These were recently published in a SIDO article, so this article will deal more specifically with bracket position, bracket selection, and arch form as it relates to these four factors;

- **Idealized inclination of the upper incisors and canines:** Patients are more sensitive to adverse changes in axial inclination than to changes in A/P position[6]
- **Idealized smile arc**: Idealized smile arcs are more attractive especially in women[7]
- **Incisal and Gingival display:** Some gingival display, and full enamel display is appropriate in a "posed" smile[8]
- **Wide arch width, particularly in the molars:** Smiles with small buccal corridors are more aesthetic, in both men and women[9].

Placing anterior brackets in a more gingival position improves enamel and gingival display by adjusting the vertical position of the upper incisors and cuspid relative to the upper posteriors. (Figure 1, 2, 3). Lower posterior brackets are placed in a more gingival position to avoid the occlusion, and the lower anterior bracket more incisally to intrude the lower anteriors and optimize overbite (Figure 4,5).

This approach to bracket placement has come to be called the **"SAP"**[10] **Smile Arc Protection** approach. The specifics of this approach have been published several times[5 11 12], so rather than review those details again, I will cover the positive impact esthetics that SAP[10] produces.

- **"Positive and negative" coronoplasty** is very important. Patients today want beautiful faces, beautiful smiles, and beautiful teeth. Teeth need to be "optimized" for shape and contour. When done prior to bonding, esthetic re-contouring improves the ability to place brackets in the appropriate location to maximize the smile arc, optimize axial inclination, and control 1st and 2nd order changes in tipping mechanics. Prior to bonding, we encourage softening the cusp tips of the cuspids and first bicuspids, normalizing facial irregularities, and optimize length/width ratios of the upper anterior teeth. Other microesthetic aspects of contact point length, appropriate embrasure spaces, and slenderizing for tooth size discrepancies are accomplished after the anteriors are aligned. Centric stop adjustments are made during the finishing stages of treatment. All surfaces that have been adjusted are smoothed with a white stone, and black rubber tips in a high speed hand piece.

SAP Bracket Positioning:

- **"SAP Bracket Position[10]" as a tool in gaining optimal esthetics.** Straight wire theory is based on occlusal results but great occlusal results do not always provide great esthetic results. Bracket position must be individualized to patient esthetic need. In patients with "flat" occlusal planes or those requiring increased enamel display, the progression of the wire plane created by bracket position must increase to develop the smile arch by extrusion of the upper incisors relative to the upper bicuspids. In patients with normal occlusal planes a more modest progression in the wire plane is advisable to protect the smile arc as the

Figure 4: Bracket heights to the occlusal plane progress more towards the gingival the further anterior in the arch - wire plane is not parallel to the occlusal plane.

Figure 5: Lower incisor heights are more incisal to minimize overbite, optimize the occlusion, allowing vertical height adjustments of the upper anterior for smile arc - wire plane is not parallel to the occlusal plane.

upper arch broadens with treatment. Orthodontists tend to focus on intrusion of the upper anterior teeth in deep bite cases with steep occlusal planes, and excessive enamel display which can lead to esthetic decline. A modest progression in still advised in deep bite cases to avoid excessive reduction in smile arc with reduction in overbite. It is important to remember that large bracket progressions in the upper arch must be compensated for by increased "overlevelling" of the lower arch to maintain optimal overbite through bracket position.

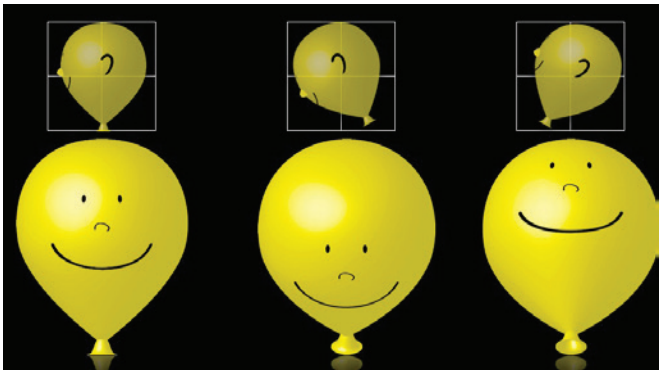

Figure 6: Impact of Head Position on Smile Arc - as the smile arc changes with head position, I use NHP (Natural Head Position) as the reference plane for aesthetic based treatment.

- **Head Position versus Frankfort Horizontal Plane in Esthetics.** The need to standardize the techniques used by orthodontists and anthropologists, to undertake diagnosis and comparative studies of head anatomy generally revolves around the Frankfort Horizontal reference plane. This plane was selected in the outcome of deliberations at 2 craniometric conferences on disarticulated skulls, held in Munich in 1877 and subsequently in Berlin in 1880, and submitted for consideration to the 13th General Congress of the German Anthropological Society held in Frankfort (or Frankfurt) in 1882. A more appropriate plane is clearly visible on a number of Leonardo da Vinci's proportional drawings[13] as a "true horizontal reference line" with the study postured in a Natural Head Position (NHP) which has become a popular reference plane for esthetically driven treatment[14]. As NHP has been shown to be reasonably reproducible, both in the short and long term[15 16 17], and smile arcs are highly dependent on the occlusal plane of the upper arch (Figure 6), I prefer using the natural head position for assessment. Patients should be assessed while standing comfortably, engaged in natural conversation, and generating unposed smiles. The Orthodontist can then make a patient specific decision regarding the bracket progression needed to generate optimal enamel display: larger progressions where more display is required, moderate progressions to protect the existing smile arc.

Bracket Torque as it effects Contemporary Esthetic Goals:

- **Realistic Expectations and Straight Wire Theory:** In straight wire theory, control of first, second, and third order tooth movement is described as being achieved by incremental increases in arch wire size and placement of the bracket slot at FA. It is required to gain optimal torque expression relative to the occlusal plane using arch wires that "fill up the slot"[18]. The recognition of the limitations of "straight wire theory" has become relatively common, with the conclusion that, **"we need to raise the need for a re-evaluation of the theories of the straight-wire appliance in orthodontics."**[19]

Few orthodontists fill the slot, so that the prescription "built into" the bracket is seldom expressed. Actual torque expression then is the result of many factors: bracket design, wire/slot play (engagement angle) mode of ligation, bracket deformation on loading, wire stiffness, magnitude of wire torsion, corner radius, initial tooth position, bracket position, and tooth anatomy[20]. The combination of these effects makes creating torsion within the appliance difficult when relying on incremental increases in wire size, without bending wire (Figure 7) using traditional bracket positions. This is especially problematic in non-extraction, crowded cases where incisor flaring created during the tipping phases of treatment is very difficult to recover later.

"Today's Orthodontist practices at the intersection of art and technology. The challenge of applying appropriate levels of technology to an artistic end result is the art of case management. The best case managers have a sound understanding of the technology they apply on a daily basis".

Fortunately in the "SAP[10]" - **Smile Arc Protection** - approach, with bracket placement guided by esthetic requirements, benefits arise in the area of third order control.

- **SAP[10] bracket positions are more effective in management of axial inclination early in treatment.** This is true during the tipping phases of treatment. Early in treatment, incisor extrusion creates a retroclining movement that helps control proclination as crowding unravels, when supported by ELSE (early light short elastics) and proper disarticulation buttons. Case Management is the key early in treatment, with needed torsion created by wire plane and disarticulation and supported by early elastics.

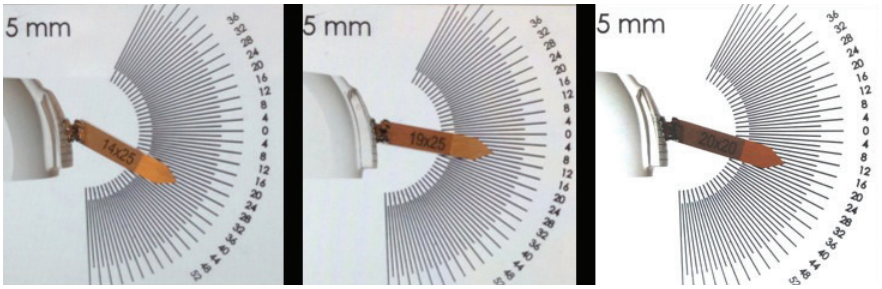

Figure 7: Incremental increases in arch wire fail to provide lingual crown torsion when the slot is not filled.

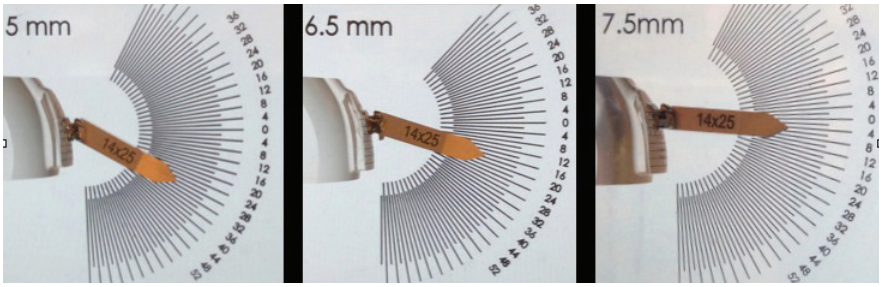

Figure 8: SAP bracket positions decrease the angle of engagement, thereby improving control of axial inclination in dimensional wires.

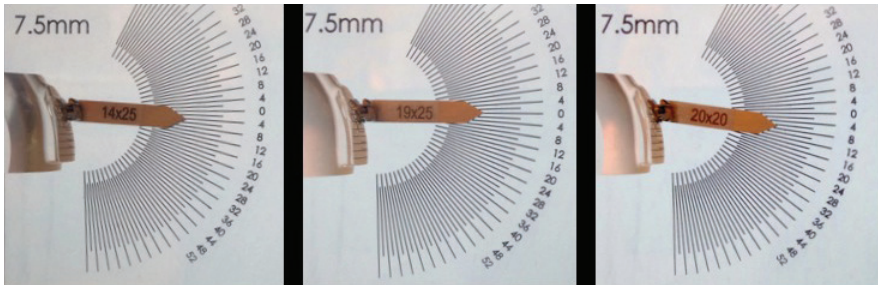

Figure 9: Even with extreme SAP positions, it is unlikely to develop excessive torsion within the slot, with common arch wire progressions.

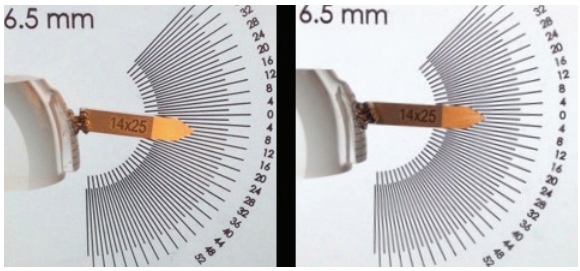

Figure 10: "Flipping" the brackets, reduces the angle of engagement further, allowing torsional couple to be developed in light dimensional wires.

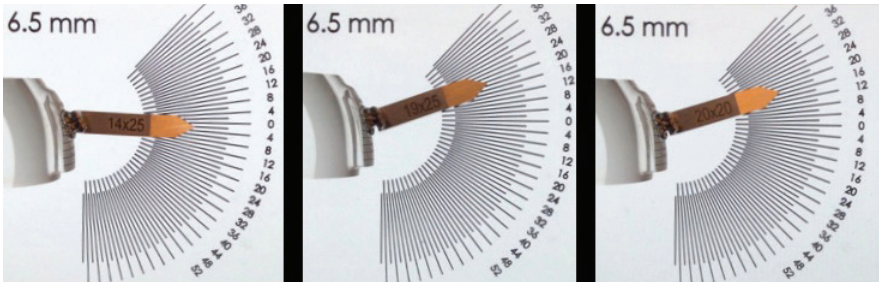

Figure 11: Increased AW sizes in "flipped" brackets produce torsional couples within the slot to effectively upright teeth.

- **Other key case management principles: ELSE, disarticulation, and AW progression are more effective.** When using SAP[9] bracket positions, improvements in esthetic and functional occlusions occur in the first few appointments. Patients notice these changes, and we encourage the use of "every patient/every appointment photography" as a means of validating the mechanical setup and the progress of treatment.

- **SAP[10] bracket positions are more effective in management of axial inclination during the torsional phase of treatment.** This attribute is a key contributor to a case management philosophy that allows changes in both transverse and axial inclination far earlier in the treatment cycle that traditional straight wire treatment would allow. There are other aspects to this "active early" approach which will be appearing in the next few months for those who are interested, but briefly:

- **SAP[10] bracket placements reduces the angle of engagement** by reducing the torque designed into the Rx, which is advantageous in cases with proclined teeth, crowded upper anteriors, or to recover proclination occurring as a result of relief of crowding (Figure 8). By applying active torsion within the appliance sooner, with lighter forces, treatment has the potential to be both more efficient and more comfortable for the patient.

The "10 tooth smile" is touted as representing an esthetic ideal. There are however many excellent students of dental esthetics that prefer a "12 tooth smile" esthetically, and I agree with them.

- **Secure Force Application:** Even with very large SAP[10] progressions, **application of excessive torsion through incremental increases in wire size is unlikely** using commonly employed AW sequences (Figure 9).

I have been an advocate of the PSL bracket system for the last 15 years of my career. I utilize Ortho Classic's H4 bracket exclusively, and have been very pleased with the performance of the appliance. The familiar Rx *(12/8/7) in the upper anteriors, solid gate, .026 depth slot*, combined with utilization of "Pitts Standard" and Pitts Broad" arch forms has increased efficiency tremendously.

Choosing the right torque bracket or groups of brackets can minimize arch wire adjustments in finishing, but the development of "variable torque" appliances has complicated this relatively simple concept. Rather than picking a bracket torque from a constellation of variable torque Rx's on a tooth by tooth basis, torque selection has been simplified in the **"active early"** approach to reduce the arch wire adjustments in finishing.

With North American patients seeking broader smiles and fuller lips, treatment has trended towards avoiding bicuspid extractions to achieve that goal, frequently with the adverse side effect of proclined upper anteriors, which is difficult to recover, and not desirable esthetically.

Bracket inversion as a means controlling axial inclination:

Inverting brackets (***"flipped"***) as a means of creating more lingual crown torsion has been a common case management practice for years, usually as applied to controlling single teeth. Earl Johnson[21] provided a very nice summary of using this approach as it is applied to controlling axial inclination of upper lateral incisors. Some companies advocate using "low torque" prescriptions as a means of uprighting proclined teeth, but the reality is that the torque selections involved are frequently not sufficiently negative to accomplish that task. Research indicates that torsion of 20 to 25° between the bracket slot and arch wires (19X25) are required to create the requisite forces[22], and this is very close to that attained with "flipped" brackets placed at SAP positions, utilizing commonly used wire sequences (Figure 11).

One of the strategies used in an "active early" approach is to invert ("flip") groups of upper anterior brackets as a means of creating lingual crown torsion earlier in the treatment cycle. This technique dramatically reduces "slop" within the bracket wire interface by lowering the angle of engagement at the outset (Figure 10) and applies active lingual crown torsion with incremental increases in arch wire size (Figure 11). One of the critical aspects of this approach is that in the inverted or "flipped" Rx, more lingual crown torsion must be applied to the central than the lateral incisor, due to root size, allowing uprighting of the teeth with minimal adjustment to the wire in finishing. Again the H4 Rx provides appropriate torque when "flipped" **(-12/-8)** for **uprighting proclined teeth, compensating for proclination created during unravelling of crowding, or counteracting the effects of class III mechanics. (Figures 12 to 18)**

It has been suggested that when applying "single tooth" activation by "flipping" individual brackets requires that the bracket be uprighted or the wire adjusted once an ideal inclination is achieved[18], which is one of the reasons that I suggest "flipping" brackets in groups to activate the appliance. In crowded cases it is desirable to "flip" the upper cuspid bracket to avoid

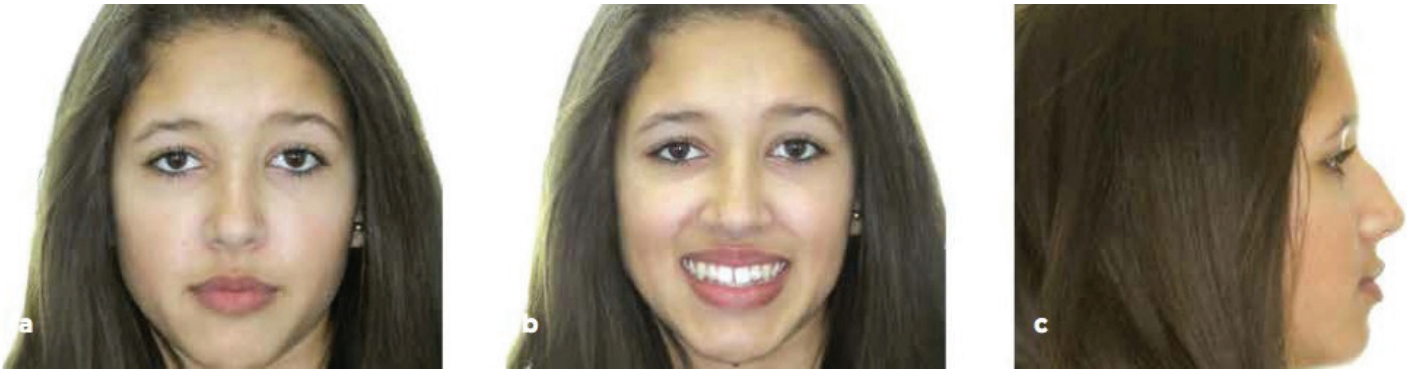

Figure 12: Sample Case: Extra Oral Photographs.

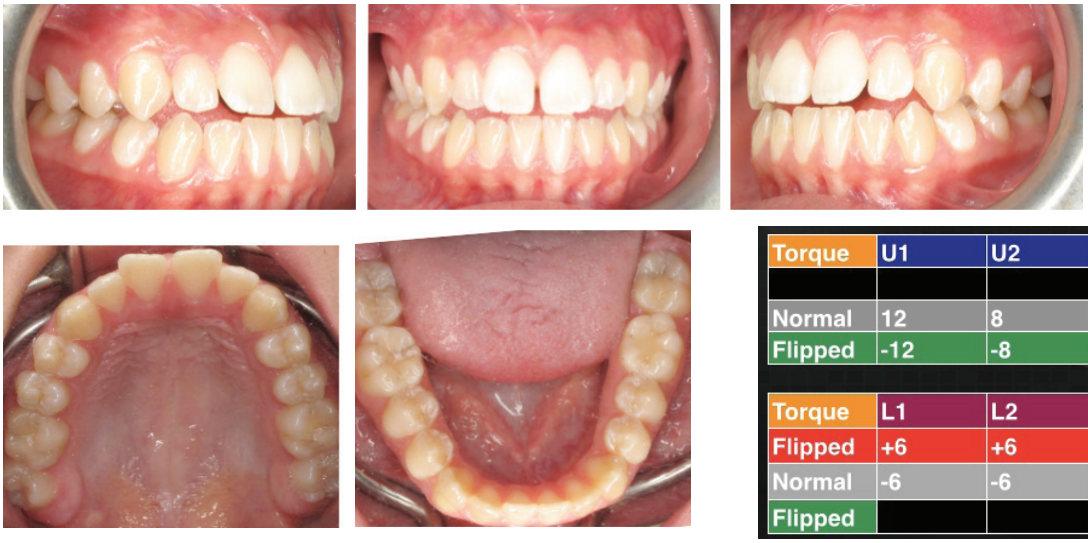

Figure 13: Sample Case: Intra Oral Photographs

Torque	U1	U2	U3	U4	U5
Normal	12	8	7	-11	-11
Flipped	-12	-8	-7		

Torque	L1	L2	L3	L4	L5
Flipped	+6	+6			
Normal	-6	-6	7	-12	-17
Flipped			-7		

Figure 12: Impact of Inverted Brackets - wide selection of torque values achievable with "flipping" brackets in the H4 appliance. This can be utilized in most cases to minimize wire bending while simplifying inventory considerations.

"paddling" of the cuspid with arch development, relief of anterior crowding, or to compensate for the adverse effects of localized torsion in the appliance. In this approach, with the four incisors and cuspids "flipped", all the anteriors have negative torque ("flocked"), allowing uprighting of the anterior segment with an unbent wire.

One of the reasons I have adopted the Ortho Classic's H4 bracket system is that combination of upright and inverted H4 brackets provides a good variety of torques to choose from, that are applicable in most situations (Figure 12), with a minimal inventory cost to the practice.

Arch Form as it effects Contemporary Esthetic Goals:

The "10 tooth smile" is touted as representing an esthetic ideal. There are however many excellent students of dental esthetics that prefer a "12 tooth smile" esthetically[23], and I agree with them. Arch form is directly related to the shape of the wire used, not to the bracket system an orthodontist decides to use[24]. With this in mind, I do not use "standard arch blanks" but shape bendable arch wire to optimize posterior arch development for esthetics. Careful assessment at each appointment, with palpation of the buccal and lingual alveolar processes is required to ensure that the patient's "biological availability"[5] is not compromised.

I have always been challenged by arch forms that are too flat anteriorly, too broad through the cuspid and first bicuspid, and too narrow through the second bicuspid and molars. I have found all commonly used arch forms to be inadequate in terms of width in the posterior sections, where transverse arch development provides significant advantages from an esthetic perspective. Wider arches posteriorly also provides the opportunity to gain space and relieve crowding, which is very useful in non-extraction cases.

Fortunately two companies now produce arch forms that mimic this shape; Ortho Classic's Pitts Standard and Pitts Broad arch forms, and G&H Wires DYB V3 arch forms both function well. Because research has shown that as much posterior arch development occurs in round wires as occurs in dimensional arch wires[21], both these suites have round, square, and rectangular wires in the same arch form. This feature facilitates an **"active early"** approach to transverse arch development with a greater degree of torsion control whether using familiar wire progressions or square wire progressions when using Ortho Classic's H4 appliance.

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Dr. Pitts has been published in multiple journals and clinical publications. He has been actively teaching the orthodontic community in a variety of setting both nationally and internationally since 1986.

Figure 14: SAP bracket placement, inverted upper anteriors, posterior bite turbos, ELSE (short class III through the bite elastics. Notice the bracket progression increases as through out the buccal segments and anteriors.

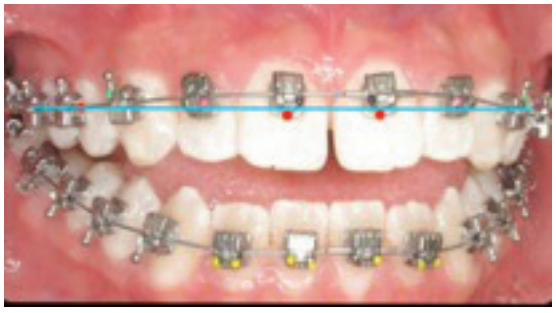

Figure 15: SAP bracket placement: bracket slot are positioned apical to FA to develop the smile arc.

Figure 16: Improvement in smile arc, gingival display during the tipping phase of treatment

Figure 17: Improvement in axial inclination during the tipping phase of treatment due to case management.

Figure 18: Inverted brackets on the upper anteriors engage a couple early in treatment in light thermally activated dimensional wires. Notice the absence of a couple in the lower arch!

Where unadjusted nickel-titanium or beta-titanium arches do not have optimized axial inclination, **the practitioner can use shapeable beta-titanium arch wires or stiffer stainless steel to efficiently correct remaining aberrant torque situations.**

Summary and the Role of Case Management:

I have always been a teacher. During my career I have concentrated on the development of improved simplified "case management" practices, combined with a sound understanding of the impact of varying bracket position, bracket torque and use of modern arch wires forms to assist the orthodontist in creating an artistic end result. Applying these principles will make case management more efficient, and improve the quality of your end results.

Today, I choose to activate the appliance as early as possible, using the SAP[10] bracket position to adjust vertical position of the incisors, inverting groups of brackets to activate the appliance, selecting arch wire progressions that control axial inclination early in treatment, and using arch forms that develop the posterior segments of the arches sooner. We will be sharing more on the "active early" approach in the coming months, so stay tuned!

Until next time.....

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Author's Comments

Dr. Tom Pitts

Dr. Duncan Brown

"Our goal in teaching continues to be to improve esthetic and functional outcomes, while simplifying treatment mechanics and improving predictability, and efficiency. Combining the "14 Keys of Pitts Case Management", an "Active early" approach to treatment, and superior OC H4 self-ligating brackets with Pitt's Broad Arch Forms has gone a long ways to achieving those ends."

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